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Eighty nursery school children were randomly divided into four groups of 20 and given a serial short-term memory task in which difficult-to-label stimuli were used. Three experimental groups were provided with labels for the stimuli. Of these, one group overtly pronounced the labels and rehearsed them during the task, one group merely pronounced the labels overtly, and one group was instructed to say the labels covertly. A control group received no labels for the stimuli. Rehearsal of the labels was found to facilitate recall performance on early serial items, and overt labeling facilitated recall on the last serial item. Covert labeling did not facilitate recall. The results supported the hypothesis that qualitatively different processing strategies determine primacy and recency effects. Current theories of the role of verbalizing in children's memory performance are discussed. (Author/MS)

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Center for Human Growth and Development

Induced versus Spontaneous Rehearsal in Short-term Memory in Nursery School Children

by

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Development of Language Functions

A Research Program-Project

(Study M: Development of Selective Attention Abilities)

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Abstract

Four groups of nursery school Ss were given a serial short-term memory task in which difficult-to-label stimuli were used. Three experimental groups were provided labels for the stimuli. Of these, one group overtly pronounced the labels and rehearsed them during the task, one group merely pronounced the labels overtly, and one group was instructed to say the labels covertly. A control group received no labels for the stimuli. Rehearsal of the labels was found to facilitate recall performance on early serial items, and overt labeling facilitated recall on the last serial item. Covert labeling did not facilitate recall. The results supported the hypothesis that qualitatively different processing strategies determine primacy and recency effects. Current theories of the role of verbalizing in children's memory performance are discussed.

Induced versus Spontaneous Rehearsal in Short-term Memory in Nursery School Children

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Developmental studies by Hagen and Kingsley (1968), using an eight-item serial short-term memory (STM) task, found facilitated recall on the part of Ss who labeled stimulus items aloud over Ss who did not overtly label. However, this finding characterized only first- to third-grade Ss and not older and younger children. Facilitation of STM performance by overt labeling was confined largely to the most recent serial positions (recency) for all CA levels studied and this effect was relatively constant across ages. Recall of early presented items (primacy) was little affected by overt labeling until Grade 5, at which point it was hindered by overt labeling. However, primacy performance did show improvement with age from nursery school to fifth-grade, whether labeling was overt or not, in contrast to recency performance which changed little with age. Hagen and Meacham (1967), using a similar STM task and fourth-, sixth-, and eighth-grade Ss, obtained results which are consistent with those of Hagen and Kingsley.

A recent study by Bernbach (1967) suggests that in serial STM a primacy effect may be the result of rehearsal of stimulus items, since the early items presumably could be rehearsed more than intermediate and later items. Keeney, Cannizzo, and Flavell (1967) have found that overall recall (disregarding serial position effects) is significantly facilitated when young Ss are induced to rehearse; and Flavell, Beach, and Chinsky (1966) found a marked increase in the incidence of spontaneous rehearsal with increasing CA between kindergarten and fifth-grade. Thus recall on early serial items

should improve with increasing CA because of a greater tendency to rehearse. This age-related rise in primacy scores was found in the Hagen and Kingsley, and Hagen and Meacham studies; however, depression of primacy scores by overt labeling for older Ss may have resulted from interference by overt verbalization with the preferred rehearsal strategy of these Ss.

On recent items, for which rehearsal should not play a large role, no age-related improvement was found by Hagen and Kingsley. But on these items overt verbalization of labels had a facilitative effect. This effect may well result from a more direct STM phenomenon than rehearsal: verbal labels pronounced aloud very recently may briefly produce a stronger memory trace and better short-term recall than no overt verbalization.

Thus the Hagen and Kingsley studies, together with those of Bernbach, Flavell et al., and Keeney et al., suggest the following hypothesis: In a serial-order STM task, recall of the early items is a function primarily of rehearsal of labels for stimuli and therefore shows improvement with an increase in CA, or, for young Ss, with induced rehearsal. Recall of the most recent items, on the other hand, is the result of a very short-term memory trace for an item and shows facilitation when the stimuli are labeled overtly, but this effect is not related to CA.

In the present investigation a test of this hypothesis was made by manipulating two variables: overt vs. covert labeling of stimuli and spontaneous vs. induced rehearsal of the labels for the stimuli. Difficult-to-label stimulus items were used in an STM task similar to that of Hagen and Kingsley. Nursery school children served as Ss since they would likely neither spontaneously label or spontaneously rehearse the labels for the stimuli. Three experimental groups were used and Ss in these groups were given labels for the stimulus items. The experimental groups were:

(1) Group CS (Covert labels, Spontaneous rehearsal) in which Ss were instructed to say the labels subvocally during the STM test.

(2) Group OS (Overt labels, Spontaneous rehearsal) in which Ss were required to overtly label the stimuli during the test.

(3) Group OI (Overt labels, Induced rehearsal) in which Ss were required to overtly label and rehearse the stimuli during the test.

In addition, a group of control Ss, Group N (No labels), performed the task with no labels provided for the stimuli.

The induced rehearsal group (OI) was predicted to show better recall than the other groups on early serial positions, while the two overt label groups (OI and OS) were expected to perform better on recent serial items than the non-overt groups (CS and N). Group CS had labels available and thus had the possibility of rehearsal; it was therefore predicted to perform better than Group N on early and intermediate serial positions. The four groups were expected to rank on overall performance as follows: OI > OS > CS > N.

Method

Subjects

Ss were 80 children attending a private nursery school in Sylvania, Ohio, and were mostly from middle and upper-middle class homes. Four groups of 20 Ss were randomly chosen, each consisting of 10 girls and 10 boys. Mean CAs for the four groups were: Group OI, 5.0 years (SD = 0.3 years); Group OS, 5.1 years (SD = 0.3 years); Group CS, 5.1 years (SD = 0.3 years); Group N, 5.2 years (SD = 0.2 years).

Materials

Stimulus materials consisted of a set of six nonsense figures used by Glucksberg and Krauss (1967; see Figure 1) drawn in black on white 3" X 2 1/2" cards. These figures were chosen on the basis of pretests as being relatively difficult for young children to label spontaneously, yet distinctive enough that a unique label could easily be learned for each. Upon first exposure to the stimuli almost all Ss reported that they did not recognize or could not identify the figures. However, Ss in the label conditions were all able to name the figures correctly within one or two trials after the labels were given. Labels for the stimuli were meaningful one-syllable words chosen to describe as appropriately as possible the nonsense shapes they designated (Figure 1).

Insert Figure 1 about here

Procedure

The procedure for all four groups was as follows: E seated S at a table opposite him and defined the situation as a game. M & M candy rewards were displayed. Then the six stimulus cards were laid face-up in front of S. After S was asked if he knew what any of the figures were, E told those in the label conditions (OI, OS, and CS) the names for the stimuli and S pointed to each while naming it aloud. In order to give Ss in the non-label condition approximately equal initial exposure to the stimuli, E counted the six stimuli out loud for Ss in Group N, then had S in turn point to each and count.

Ss next received two pretest trials on the STM task. On each trial S was presented five of the stimulus figures one-by-one, each being laid face-down on the table after it was presented to form a row from S's left to right. After presentation of the fifth card, E presented a cue card identical to one of the five test cards. S's task was to turn up the correct test card while turning up as few incorrect cards as possible. Ss were permitted to continue turning cards over until they found the correct one, but they were rewarded with an M & M only on trials in which their first response was the correct one.

Immediately following the two pretest trials, Ss were given 10 test trials, on each of which E recorded the card turned up on the first response and the number of incorrect responses made. One-half of the Ss in each group received one or the other of two different sequences of 10 trials. Each sequence consisted of 10 subsets of five of the six stimulus cards, with each subset having a different serial order of cards from the other nine. One subset was used per STM trial. Each of the five serial positions was correct on 2 of the 10 trials, a different stimulus figure being correct on each of the two tests at a serial position. Thus within each group of Ss there were tests on four different stimulus figures at each of the five serial positions.

Several variations in this basic procedure produced the three experimental groups. Ss in Group OI, beginning with the two pretest trials, were required to name aloud each card presented them, including the cue card. Following each presentation of a stimulus card and after the card was laid face-down on the table, Ss were also required to rehearse out loud and in order all of the cards previously presented to them for that trial. E prompted or corrected when S forgot the next card in the rehearsal sequence or named the wrong card. However, all Ss were required to themselves verbalize all items in the correct order in each rehearsal sequence whether they needed prompting from E or not.

Ss in Groups OS and CS were required, beginning on the two pretest trials, to say aloud the label for each card presented them, including the cue card. However, while this procedure was continued throughout the 10 test trials for Group OS, Ss in Group CS were instructed, after the pretest trials and just before the 10 test trials, to stop saying the labels out loud and rather to "just say them silently inside your head." Midway through the trials a subset of Ss in Group CS were asked to again name the six stimulus figures. Ss who were asked could still correctly label all the figures. Ss in Group N were not told the labels for the stimuli and merely observed the figures silently as they were presented.

For the non-rehearsal groups (OS, CS, and N), in order to keep the presentation rate the same as for the rehearsal group (OI), E himself carried on the rehearsal process covertly. He presented each stimulus card upon completion of his covert rehearsal of the preceding cards, thereby matching the between-item intervals of Group OI. Ss in these groups thus had the opportunity to spontaneously rehearse if they were so inclined.

Results

Figure 2 shows forgetting functions depicting proportion of correct first responses as a function of serial position and experimental group. Serial position 1 represents

the first card presented to a S; position 5 represents the most recently presented card.

Insert Figure 2 about here

A two-way analysis of variance for repeated measures on one factor (Winer, 1962) revealed significant main effects for the two factors: serial positions ($F = 27.30$; $df = 4, 304$; $p < .001$), and experimental groups ($F = 7.59$; $df = 3, 76$; $p < .001$). An interaction between serial positions and experimental groups was also present ($F = 2.38$; $df = 12, 304$; $p < .01$). As is evident in Figure 2, the serial positions effect resulted from high recency and lower primacy scores in all groups. The experimental groups effect, as indicated by a post-hoc comparison of means (Hays, 1963), was contributed to by significant differences between the rehearsal group (OI) and the combined non-rehearsal groups (OS, CS, N) ($p < .01$). Also, the combined overt label groups (OI and OS) performed significantly higher than the combined non-overt label groups (CS and N) ($p < .01$).

Since primacy and recency effects were hypothesized to vary as a function of experimental treatments, a further examination was undertaken in which one-way analyses of variance were carried out for scores at serial position 1 and at serial position 5. At serial position 1 (primacy), significant differences between experimental groups were disclosed ($F = 9.42$; $df = 3, 76$; $p < .001$) and a post-hoc comparison of means showed Group OI to be significantly higher than the three non-rehearsal groups combined or individually ($p < .01$). At serial position 5 (recency), a significant experimental groups effect was also obtained ($F = 3.60$; $df = 3, 76$; $p < .05$) and a post-hoc comparison of means revealed significant differences between Group OI and Group N and between Group OI and the combined non-rehearsal groups (OS, CS, N) ($p < .05$). The combined overt label groups (OI and OS) were not significantly different from the combined non-overt label groups (CS and N) or from Group N alone at $p < .05$. Essentially the same primacy

and recency results were evident when relative primacy and relative recency scores were used. Relative primacy was defined as the difference between correct first response scores at serial position 1 and the mean of those at positions 2, 3, and 4, and relative recency was similarly defined for serial position 5.

Distributions of first responses, whether correct or not, were examined for the four groups. These distributions revealed a response bias, especially for Groups OS, CS, and N (non-rehearsal groups) in that frequencies of first responses at serial position 3 were considerably higher than those at other serial positions. Calfee (1967) has suggested a method for looking at serial recall data that takes response bias into account. The serial recall curves of Figure 2, termed the *a priori* curves by Calfee, answer the question, when position *i* was tested, how often did *Ss* choose it. These curves depict the proportion of correct first responses per serial position as a function of the number of tests at a position. Another question can be asked of the data, namely, when *Ss* chose position *i*, how often was it correctly chosen. Curves based on this question depict the proportion of correct first responses per serial position as a function of the number of first responses made at each position and are termed *a posteriori* curves by Calfee. While the *a priori* curves are said to reflect both memory strength and response bias, *a posteriori* curves take response bias into account and reflect memory strength alone (Calfee, 1967). *A posteriori* curves for the present data appear in Figure 3.

Insert Figure 3 about here

The data were also examined for evidence of either "fatigue" or learning effects through trials by comparing correct first response scores on the first five trials with those on the last five trials. All groups performed slightly higher on the first five trials and the difference approached significance by analysis of variance ($F = 2.86$; $df = 1, 76$; $p < .10$); however, there was no interaction between this factor ("fatigue") and experimental groups ($F < 1.00$).

Approximate mean testing times per S for the four groups were: Group OI, 26.6 minutes; Group OS, 21.3 minutes; Group CS, 22.1 minutes; and Group N, 20.7 minutes. Thus testing times for the rehearsal group (OI) were somewhat longer than for the non-rehearsal groups despite the attempt to gauge presentation rates for these groups to match that of Group OI.

Discussion

The hypothesis concerning rehearsal effects on primacy performance was confirmed. The rehearsal group (OI) performed much better at serial position 1 than the non-rehearsal groups. However, the non-rehearsal groups did not rank on primacy performance as might have been expected. Although Groups CS and OS had labels available for use in rehearsal, neither was significantly different from Group N in primacy performance. Failure to find differences in scores among the non-induced-rehearsal groups here is probably due to the fact that Ss of this age do very little spontaneous rehearsing even when labels and time are available, as was found by Flavell et al. (1966).

STM performance on the intermediate serial positions in terms of a priori probabilities further supports the rehearsal hypothesis (Figure 2). Since Ss in Group OI rehearsed the stimulus at serial position 1, five times; that at position 2, four times; that at position 3, three times; etc., the obtained gradual decline in scores from position 1 to position 4 is almost exactly what would be predicted from an hypothesis attributing facilitation of STM to rehearsal. The serial position curves of the three non-rehearsal groups show no such regular decline across serial positions 1 to 4, and, in fact, display a rise in scores at serial position 3. This rise reflects a response bias, probably a result of the fact that position 3 was the middle one of a relatively short list. The response bias can be considered evidence for the lack of a systematic STM strategy on the part of the spontaneous rehearsal groups. The contrast between the performance of these groups and that of Group OI, where rehearsal was used and STM scores varied directly with the amount of rehearsal, points to the facilitative effect of rehearsal on early items in the STM task.

On the most recent serial position, the four groups ranked in the a priori curves as expected. However, Group OS was predicted to perform more nearly like Group OI and less like Groups CS and N, since labels were overt for both OI and OS and not for CS and N. The low performance of Group OS may be partially explained by considering an inadvertently introduced difference in experimental procedures for the rehearsal group and the non-rehearsal groups. For the non-rehearsal groups (OS, CS, and N) E covertly rehearsed after each presentation of a stimulus including the last one, while Ss in Group OI themselves overtly rehearsed. Thus the Group OI Ss made their first recall response almost immediately after overtly rehearsing the five stimuli, but for Ss in Groups OS, CS, and N there was an 8-10 second pause before their recall response during which E rehearsed the five stimuli covertly. The lower performance of Group OS in comparison to Group OI at serial position 5 might be attributed to this difference in experimental procedure were it not for the fact that Group OS performed, in a posteriori terms (Figure 3), as well as Group OI and considerably better than the non-overt groups at position 5. Memory strength (i.e., probability of a correct response given the occurrence of a response) at position 5 was slightly greater for Group OS than for Group OI. Thus the effect of a brief pause, when labels are overt, seems to be to reduce the probability of a response at position 5 unless S is relatively certain that the response is correct; i.e., with response bias taken into account, overt labeling appears to strengthen the memory trace for the most recent serial item when there is a short presentation-to-test delay. Hagen and Kingsley (1968) found recency performance facilitated by overt labeling with no presentation-to-test delay. This result agrees with both a posteriori and a priori no-delay findings for Group OI in the present study. The hypothesis that overt verbalization of labels facilitates performance on the most recent serial item seems to be confirmed.

The a priori serial performance curve of Group OI seems to offer information relevant to the question of whether or not a distinction between long-term memory (LTM) and STM should be made. If LTM is defined operationally as involving rote-learning

procedures while STM involves a single stimulus presentation with no opportunity for practice (Kausler, 1966, pp. 476, 534; Glanzer and Cunitz, 1966), then the experimental treatment applied to Ss in Group OI would seem to provide measures of both LTM and STM. Four of the five serial positions were practiced (rehearsed) in varying amounts while the fifth was essentially unpracticed; but the continuity between no practice at serial position 5 and five practice trials at serial position 1 was intact, i.e., the progression from no practice to five practice trials involved equal increases in practice at each point. Yet the serial recall curve seems clearly discontinuous, with two distinct segments apparent: a portion (serial positions 1 - 4) which varies directly with amount of practice and resembles a learning curve, and a portion (serial position 5) which varies with factors other than practice (presumably factors directly affecting STM), e.g., overt pronounciation of stimulus items, presentation-to-test delay. This analysis supports the conclusion of Glanzer and Cunitz (1966) and Ellis and Hope (1967) that the bow-shaped serial recall curve can be viewed as consisting of distinct LTM and STM components produced by different recall processes and perhaps involving different storage mechanisms. Overt labeling is suggested as a variable affecting STM processes, in addition to the variable indicated by Glanzer and Cunitz, and Ellis and Hope, namely, time elapsed between presentation and recall.

The four groups were ranked in overall STM performance as predicted, except that Group N was slightly, but nonsignificantly, higher than Group CS. Thus mere possession of labels for stimuli (Group CS) does not facilitate recall performance over absence of labels (Group N) for this age S. The "production deficiency hypothesis" of Flavell et al. and Keeney et al. is supported by this finding, since production (overt verbalization, or rehearsal, or both), but not possession, of labels was facilitative for these young Ss.

It should be pointed out that, while the Ss of the Keeney et al. study apparently mastered the induced rehearsal strategy relatively easily, the Group OI Ss of the present study had considerable difficulty. However, the Keeney et al. Ss were first graders while the present Ss were nursery school children, and Keeney et al. used, in addition

to 5-item lists, 3-item and 4-item lists which made their memory task easier than that of the present study. Most of the Group OI Ss understood in principle what was required of them, but only a few actually had much success in consistently and correctly rehearsing. Often Ss rehearsed the first two or three items relatively well but found rehearsal of four and five items difficult. It may be that the memory span for this age S was exceeded after three or four items. Thus prompting by E was necessary for most Ss; however, E usually gave Ss up to 3 or 4 seconds to recall an item in the rehearsal sequence before prompting, which accounts for the somewhat longer testing time for Group OI than for the other groups.

Several conclusions are supported: (a) In a serial STM task, performance on recency (the last serial position) is facilitated by overt labeling of the stimulus items. (b) Performance on intermediate and especially on early serial positions is much facilitated by rehearsal of labels for the stimulus items during their presentation. (c) Spontaneous use of a rehearsal strategy is not widespread among nursery school and kindergarten children. (d) The effect of possession of labels for stimuli in serial STM is not a direct one but is rather mediated by rehearsal and by overt verbalization of the labels (i.e., production responses) for Ss of nursery school age.

Footnote

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Figure Captions

Figure 1 Nonsense figures and their labels.

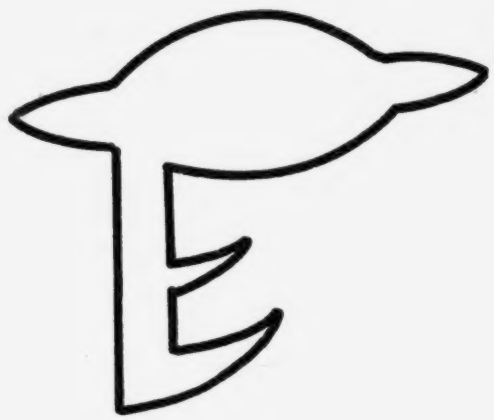
Figure 2 A priori proportions of correct first responses as a function of serial position and experimental group.

Figure 3 A posteriori proportions of correct first responses as a function of serial position and experimental group.

BELL

BUG

HORSE



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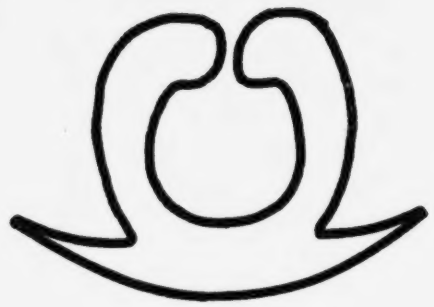

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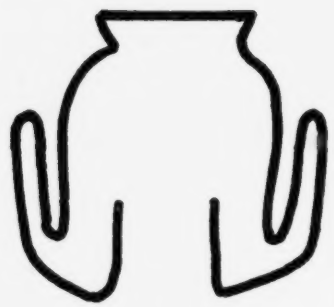
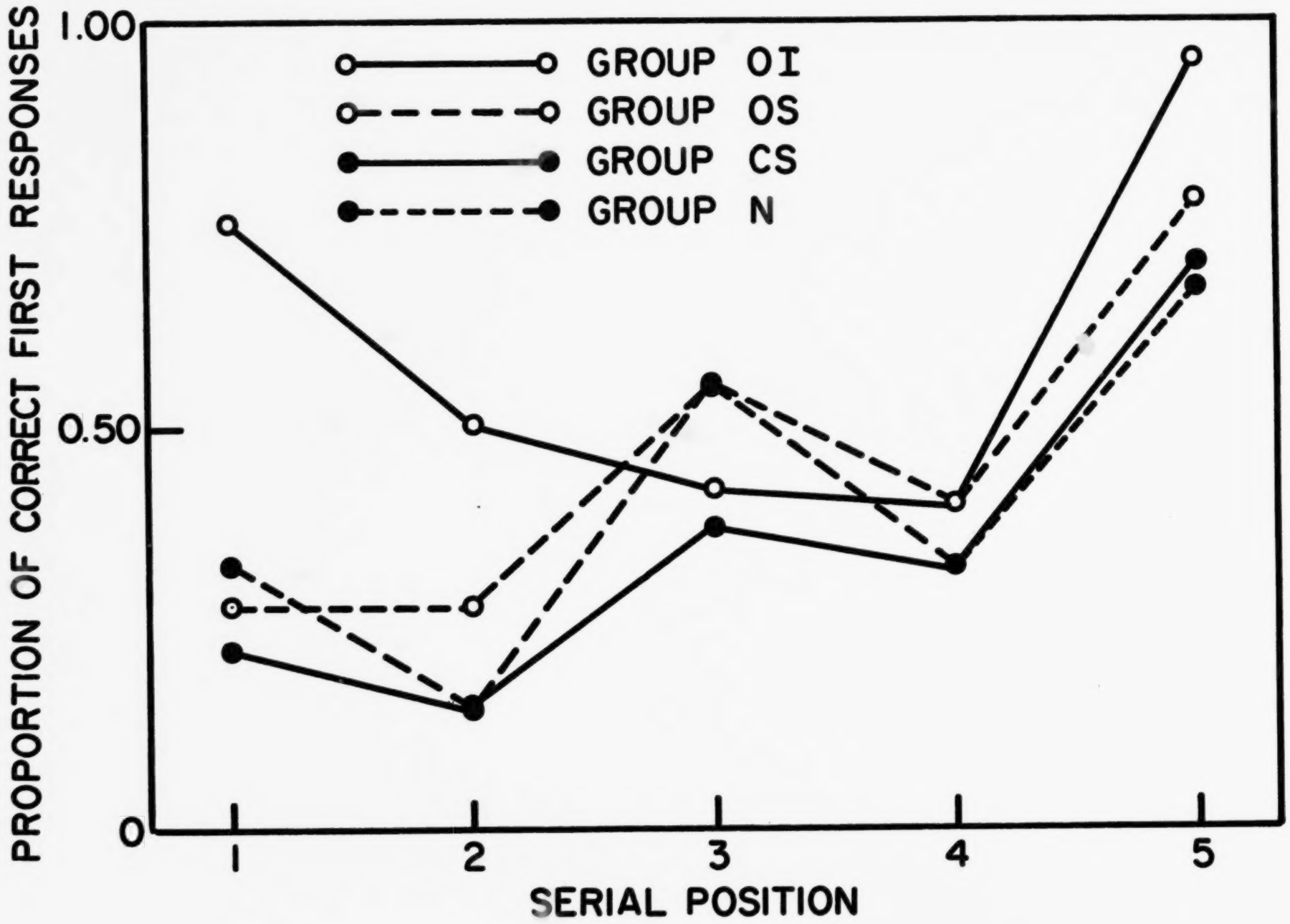


SHIRT

Figure 1


GROUP OI
GROUP OS
GROUP CS
GROUP N
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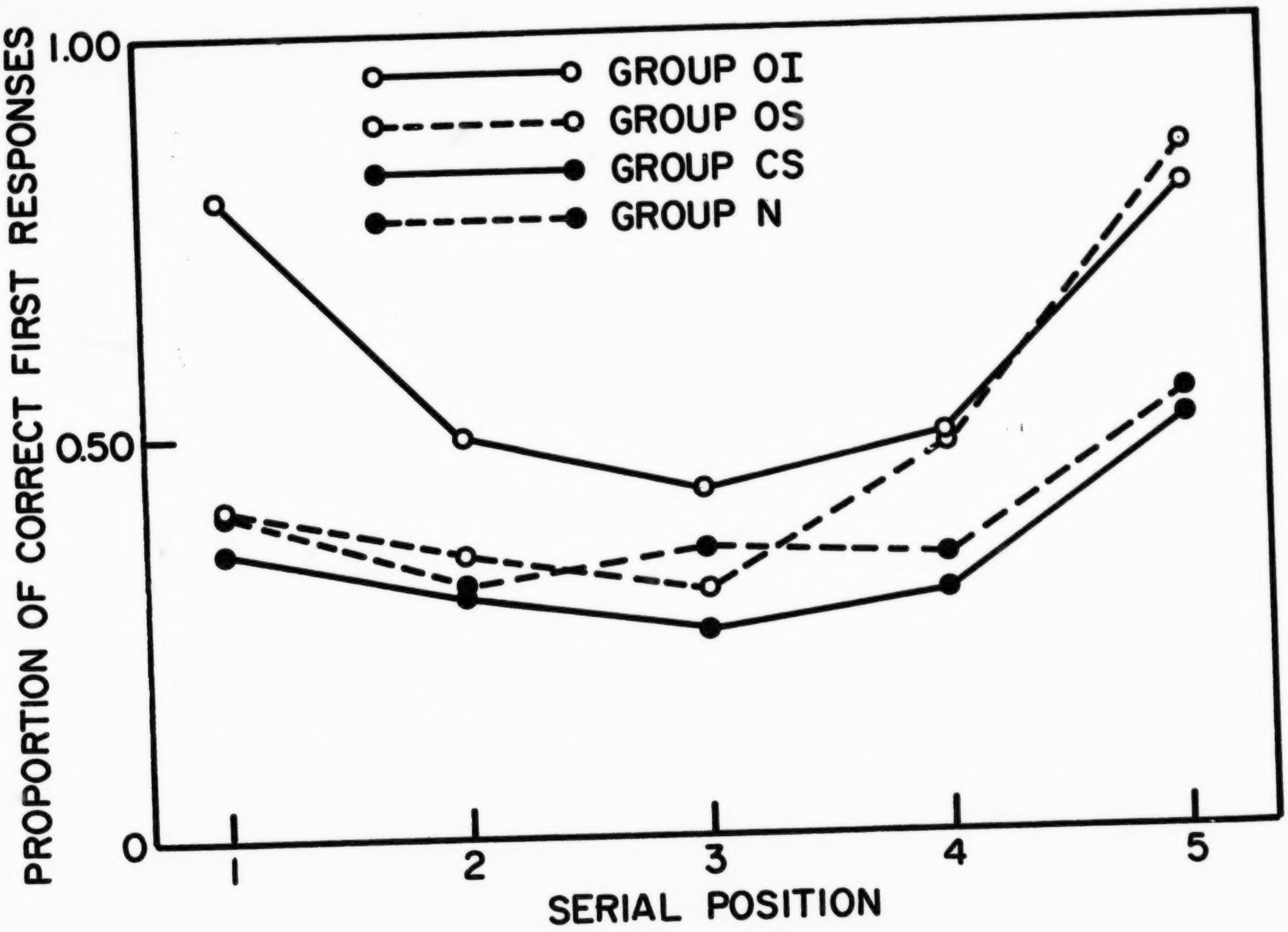
PROPORTION OF CORRECT FIRST RESPONSES
1
2
3
4
5
SERIAL POSITION

Figure 2


PROPORTION OF CORRECT FIRST RESPONSES
1.00
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GROUP OI
GROUP OS
GROUP CS
GROUP N
1
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4
5
SERIAL POSITION

Figure 3